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Full Length Research Paper

Relationship between morphological characters, dry matter yield and fruit yield of cucumber

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Field experiment was conducted during the wet season of 2008 at the Teaching and Research Farm of Ambrose Alli University, Ekpoma (Lat. 6° 45' North and Long. 6° 08' East and an altitude of 460 metres above sea level), to evaluate the relationship between farmyard manure, inorganic fertilizer and dry matter weights on the yield of cucumber. The experiment consisted of one variety of cucumber (Ashley), three farmyard manure rates and five fertilizer levels using a randomised complete block design fitted into a 3 × 5 factorial scheme with three replicates. The result of the study indicated that increasing the farmyard manure and fertilizer levels led to an increase in dry matter production and the yield of cucumber. There was a positive correlation between the total dry matter production and yield components of cucumber.

Key words: Farmyard manure, inorganic fertilizer, dry matter, yields of cucumber.

INTRODUCTION

Cucumber (*Cucumis sativus* L.) is the fourth most important vegetable crop after tomato, cabbage and onion in Asia (Tatlioglu, 1993), the second most important vegetable crop after tomato in Western Europe (Phu, 1998). It is thought to be one of the oldest vegetables cultivated by man with historical records dating back 5000 years (Wehner and Guner, 2004). In tropical Africa, the place of the crop has not been ranked because of limited use. Low soil fertility is a major constraint to crop production in Nigeria. Cucumber cultivation requires fertile soils, infertile soils results in bitter and misshapen fruits which are often rejected by consumers (Eifediyi and Remison, 2010). Bush fallowing has been an efficient, balanced and sustainable agricultural system for soil productivity and fertility restoration in the tropics (Ayoola and Adeniran, 2006), but as a result of increase in the population, the fallowing periods have decreased from ten years to three years and this has had an adverse effect on fertility restoration leading to poor yields of crops. This has necessitated the use of external inputs in the form of farmyard manure and inorganic fertilizer. Palm et al. (1997) stated the effects of organic materials on nutrients availability and acquisition and posited that organic inputs influence nutrient availability by the total nutrients added by controlling the net mineralization immobilization patterns.

The application of organic manure alone or in combination with inorganic fertilizer help in proper nutrition and maintenance of soil fertility (Talashiker and Rinal, 1986) and hence increased the dry matter content of the crop. Farmyard manure and inorganic fertilizers produce high dry matter in crop plants and this dry matter depends on the amount of photosynthetic surface they display (Ramirez et al., 1988) and photosynthetic leaf area is a limiting factor in fruit yield ability of cucumber (Pharr et al., 1985). Dry matter is related to yield. Experimentally, when source sink ratios of whole plants were lowered, net photosynthetic and net assimilate rates of leaves increased in tomato, (*Lycopersicon esculentum* L.) (Tanaka and Fajika, 1974), Beans *Phaseolus vulgaris* (Alderfer and Eagles, 1976), soybeans (*Glycine max* (L.) Merr) (Pear and Kramer, 1980) and other crops. The study was therefore carried out to evaluate the effects of

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Abbreviation: FYM, Farm yard manure.

farmyard manure, inorganic fertilizer and dry matter accumulation on the yield of cucumber.

MATERIALS AND METHODS

The experiment was conducted at the Teaching and Research Farm of the Ambrose Alli University Ekpoma on Lat. 6° 451 N and Long. 6° 081 E in a forest, savanna transition zone of Nigeria. The area is characterised by a bimodal rainfall pattern with a long rainy season which starts in late March and the short rainy period extends from September to late October after a dry spell in August. The soil order is an ultisol and the site is classified locally as kulfo series (Moss, 1957). The site was left fallow for three years after it was cropped to maize, yam and cassava for two years prior to the establishment of the experiment. A composite soil sample was collected from 0 to 30 cm depth prior to planting before the farmyard manure incorporation to determine the pH and the nutrient status of the soil. Soil pH was analyzed by 1:2 in H_2O, total N content was determined by Kjeldahl method (Bremner, 1965); available phosphorus was analyzed using the modified method of Walkley and Black (Nelson and Sommers, 1982). The farmyard manure was collected from a deep litter pen of the Poultry Unit of the Teaching and Research Farm of Ambrose Alli University Ekpoma and left to decompose for three months. The NPK fertilizer was bought from the Edo State Ministry of Agriculture and Natural Resources. The experiment commenced on the 23rd of August, 2008 with the planting of two seeds of Ashley variety of cucumber at a spacing of 75 cm × 75 cm and later thinned after two weeks to one seedling per stand to give a population of 17,777.8 plants per hectare.

This is the current recommended density of planting cucumber in Nigeria. The treatments imposed were three levels of farmyard manure (0, 5 and 10 t/ha) and five levels of NPK (0, 100, 200, 300 and 400 kg/ha). The experiment was laid out in a 3 × 5 factorial scheme with three replicates. The plot size was 3.75 × 3.75 m with 2 m pathways. The farmyard manure was uniformly spread on the plots and a West Indian hoe was used to turn the manure into the soil two weeks before planting. At two weeks after planting, NPK 20:10:10 fertilizer was applied at the rate of 0, 100, 200, 300 and 400 kg/ha to the plots; this is the period recommended for the application of NPK fertilizer in this zone. Hoe weeding was carried out at 3 and 5 weeks after planting. Insect pests were controlled with lamdacyahalothrin as Karate at biweekly intervals for effective insect control. For dry matter determination, two plants per treatment were cut from their bases at each sampling period of 4, 6 and 8 weeks after planting and separated into leaves, stems and reproductive parts (flowers and fruits). These parts were enclosed in labelled envelops and oven dried at 70°C until a constant weight was attained. These parts were then weighed and recorded (leaf, stem and fruit and total dry matter weights). At every harvest the fruit girth was assessed by using a vernier calliper, the fruit length was measured by using a flexible tape before the fruits were weighed using 10 kg scale. The cumulative weights of the entire harvest were summed up for data analysis using SAS version 17 software.

RESULTS

The effects of farmyard manure, fertilizer, farmyard manure × fertilizer interaction on the dry weight of leaves at 4, 6 and 8 WAP are shown in Table 1. The mean leaf dry weight of cucumber at 4 WAP ranged from 3.48 to 6.03 g. Dry weight of leaves was significantly affected by farmyard manure ($P<0.01$) and fertilizer ($P<0.05$) but no farmyard manure x fertilizer interaction. The mean leaf dry weight of cucumber at 6 WAP ranged from 17.09 to 27.56 g. The mean leaf dry weight was significantly affected by farmyard manure ($P<0.05$) and fertilizer ($P<0.05$) and there was farmyard manure × fertilizer interaction ($P<0.05$). As the rates of farmyard manure application increased, there was an increase in leaf dry weight. As the rate of application of fertilizer increased the values of the leaf dry weight also increased. The mean leaf dry weight of cucumber at 8 WAP ranged from 19.18 to 39.98 g. The mean leaf dry weight per plant of cucumber was significantly affected by farmyard manure ($P<0.05$) and fertilizer ($P<0.05$) and there was farmyard manure x fertilizer interaction ($P<0.01$). The mean leaf dry weight increased with increasing farmyard manure application.

The effects of farmyard manure and fertilizer on the mean stem dry weights at 4, 6 and 8 WAP are shown in Table 2. The mean stem dry weight of cucumber ranged from 1.39 to 3.46 g. The mean stem dry weight was significantly affected by farmyard manure ($P<0.05$) and fertilizer ($P<0.05$) but there was no farmyard manure × fertilizer interaction. Increasing the rate of farmyard manure resulted in the increase in stem dry weight. The mean stem dry weight per plant at 6 WAP ranged from 6.06 to 8.37 g. The mean stem dry weight was significantly affected by farmyard manure ($P<0.05$) and fertilizer ($P<0.05$) but no farmyard manure × fertilizer interaction. Raising the rate of farmyard manure led to an increase in the stem dry weight. The application of fertilizer led to a significant increase up to the 200 kg/ha rate, decreased at the 300 $kgha^{-1}$ and increased again at the 400 $kgha^{-1}$ rate. The mean stem dry matter of cucumber at 8 WAP ranged from 8.13 to 21.25 g. The mean stem dry weight was significantly affected by farmyard manure ($P<0.05$) and fertilizer ($P<0.05$) and there was farmyard manure × fertilizer interaction ($P<0.01$). Raising the rate of farmyard manure led to a significant increase in the stem dry weight accumulation. As the rate of fertilizer application increased, there was an increase in the stem dry weight. The effects of farmyard manure and fertilizer on the mean fruit dry weight of cucumber at 6 and 8 WAP are shown in Table 3. The mean fruit dry weight of cucumber at 6 WAP ranged from 3.08 to 4.53 g. The mean fruit dry weight was significantly affected by farmyard manure ($P<0.05$) and fertilizer ($P<0.05$) and there was interaction of farmyard manure × fertilizer ($P<0.01$). An increase in the rate of farmyard manure application led to a significant increase in the fruit dry weight. Fruit dry weight was also significantly influenced by fertilizer rates; an increase in the fertilizer rate led to an increase in fruit dry weight.

The mean fruit dry weight of cucumber at 8 WAP ranged from 10.49 to 24.75 g. The mean cucumber fruit dry weight was significantly affected by farmyard manure

Table 1. The effects of farmyard manure and inorganic fertilizer application on the leaf dry weight (g/plant) of cucumber at 4, 6 and 8 weeks after planting.

WAP	FYM (t/ha)	NPK fertilizer rates (kg/ha)					
		0	100	200	300	400	Mean
4	0	3.48	4.47	4.53	4.58	4.91	4.39
	5	3.74	5.34	5.44	5.50	5.68	5.14
	10	4.40	5.77	5.73	5.89	6.03	5.57
	Mean	3.87	5.19	5.23	5.32	5.54	
LSD = P<0.05, FYM means = 0.174, Fertilizer means = 0.224, FYM × Fertilizer interaction means = NS							
6	0	17.09	17.82	18.45	18.43	18.89	18.14
	5	17.42	18.42	19.20	26.24	26.45	21.55
	10	20.01	26.36	26.92	27.17	27.56	25.60
	Mean	18.17	20.86	21.52	23.95	24.30	
LSD = P<0.05, FYM means = 0.703, Fertilizer means = 0.904, FYM × Fertilizer interaction means = 1.564							
8	0	19.81	21.77	22.55	32.53	28.70	23.27
	5	21.37	32.48	38.25	33.89	34.53	31.10
	10	24.90	32.51	34.39	39.98	39.83	34.32
	Mean	22.03	28.92	31.73	32.46	34.35	
LSD FYM means = 1.034*, Fertilizer means = 1.323*, FYM × Fertilizer interaction means = 2.304**							

*, ** Significant at 5 and 1%, respectively. N.S. Not significant.

Table 2. The effects of farmyard manure and inorganic fertilizer application on the stem dry weight (g) per plant of cucumber at 4, 6 and 8 weeks after planting.

WAP	FYM (t/ha)	NPK fertilizer rates (kg/ha)					
		0	100	200	300	400	Mean
4	0	1.39	1.96	2.22	2.33	2.57	2.10
	5	1.51	2.68	2.62	2.62	2.71	2.43
	10	2.18	3.14	3.37	3.44	3.46	3.12
	Mean	1.69	2.59	2.74	2.79	2.91	
LSD = P<0.05, FYM means = 0.124, Fertilizer means = 0.153, FYM ×Fertilizer interaction = NS							
6	0	6.06	7.21	7.34	7.55	7.94	7.22
	5	6.83	7.38	8.01	8.04	8.21	7.69
	10	7.16	8.26	8.37	8.35	8.37	8.10
	Mean	6.68	7.62	7.91	7.78	8.17	
LSD = P<0.05 FYM means 0.183, Fertilizer means = 0.232, FYM × Fertilizer interaction means = NS							
8	0	8.13	12.06	16.50	16.90	18.36	14.39
	5	11.61	15.84	21.73	24.03	24.03	19.45
	10	18.24	19.89	21.25	21.18	20.43	20.20
	Mean	12.66	15.93	19.82	20.70	20.94	
LSD FYM means = 1.303*, Fertilizer means = 1.673*, Fertilizer × FYM interaction means = 2.903**							

*, ** Significant at 5 and 1%, respectively. N.S. Not significant.

(P<0.05) and fertilizer (P<0.05). There was no significant farmyard manure × fertilizer interaction. The mean fruit dry weight increased with increasing farmyard manure and as the rates of fertilizer increased, there was an

Table 3. The effects of farmyard manure and inorganic fertilizer application on the fruit dry weight (g) of cucumber at 4, 6 and 8 weeks after planting.

WAP	FYM (t/ha)	NPK Fertilizer rates (kg/ha)					
		0	100	200	300	400	Mean
6	0	3.58	3.27	3.50	3.60	3.85	3.47
	5	3.58	3.73	3.75	3.98	4.19	3.85
	10	3.17	4.19	4.44	4.53	4.50	4.16
	Mean	3.28	3.73	3.89	4.03	4.18	
LSD = 0.05, FYM means = 0.193*, Fertilizer means = 0.143*, FYM × Fertilizer interaction means = 0.241**							
8	0	10.49	12.87	17.58	18.59	23.07	16.52
	5	14.12	17.67	17.81	18.88	25.86	18.87
	10	14.97	23.61	24.49	24.75	24.01	22.37
	Mean	13.19	18.05	19.96	20.74	24.31	
LSD = P<0.05, FYM means = 1.924, Fertilizer means = 2.483, FYM × Fertilizer interaction means = NS							

*, ** Significant at 5 and 1%, respectively. N.S. Not significant.

Table 4. The effects of farmyard manure and inorganic fertilizer application on the total dry weight (g) per plant of cucumber at 4, 6 and 8 weeks after planting.

WAP	FYM (t/ha)	NPK Fertilizer rates (kg/ha)					
		0	100	200	300	400	Mean
4	0	5.24	6.43	6.75	6.91	7.31	6.53
	5	5.25	8.01	8.06	8.12	8.39	7.57
	10	6.58	8.91	9.10	9.33	9.49	8.68
	Mean	5.69	7.78	7.97	8.12	8.40	
LSD = P<0.05, FYM means = 0.243, Fertilizer means = 0.303, FYM × Fertilizer interaction means = NS							
6	0	26.22	28.29	29.29	29.64	30.68	28.83
	5	27.83	29.54	30.96	38.25	38.84	33.09
	10	30.33	38.80	39.70	40.04	40.42	37.86
	Mean	28.12	32.21	33.32	35.97	36.65	
LSD = P<0.05, FYM means = 0.763*, Fertilizer means = 0.984*, FYM × Fertilizer interaction means = 1.702**							
8	0	38.43	45.37	56.29	58.69	70.13	53.78
	5	50.70	65.99	72.79	76.80	78.75	69.02
	10	58.10	76.01	80.13	82.92	84.60	76.95
	Mean	49.08	62.46	69.74	73.80	77.82	
LSD (P<0.05) FYM means 3.482, Fertilizer means 4.504, FYM × Fertilizer interaction means NS							

*, ** Significant at 5 and 1%, respectively. N.S. Not significant.

increase in the values of fruit.

The effects of farmyard manure and fertilizer application on the total dry weight of cucumber at 4, 6 and 8 WAP are shown in Table 4. The mean total dry weight of cucumber at 4WAP ranged from 5.24 to 9.49 g. The mean total dry matter was significantly affected by farmyard manure ($P<0.05$) and fertilizer ($P<0.05$ but there was no significant farmyard manure × fertilizer interaction.

An increase in the farmyard manure rate led to a significant increase in the total dry weight accumulation. The total dry weight accumulation was significantly affected by fertilizer up to the 100 $kgha^{-1}$ rate and increased once again at the 400 $kgha^{-1}$. At 6 WAP, the mean total dry weight was significantly affected by the application of farmyard manure ($P<0.05$) and fertilizer ($P<0.05$) and there was farmyard manure × fertilizer

interaction (P<0.01). As the rate of farmyard manure was increased, there was a significant increase in the total dry weight. The application of fertilizer had significant enhancement on the total dry weight up to the 300 $kgha^{-1}$ fertilizer rate. The mean total dry matter weight of cucumber at 8 WAP ranged from 38.43 to 85.92 g. The mean total dry weight was significantly enhanced by farmyard manure (P<0.05) and fertilizer (P<0.05) but no farmyard manure × fertilizer interaction. The mean total dry weight increased with an increase in the farmyard manure rate significantly. The value of the mean total dry weight was significantly enhanced by fertilizer up to the 200 $kgha^{-1}$, beyond which fertilizer did not significantly enhance the total dry weight.

Correlation matrix of vegetative and yield traits of cucumber

The mean fruit length of cucumber ranged from 14.20 to 15.71 cm. The mean cucumber fruit length was significantly increased by farmyard manure application (P<0.05) and fertilizer (P<0.01). The values of the mean fruit length increased significantly as the rate of farmyard manure were raised. The application of fertilizer increased the fruit length at high rates of 300 $kgha^{-1}$ and 400 $kgha^{-1}$. The mean fruit weight per plant ranged from 0.91 to 2.43 kg. The cucumber mean fruit weight per plant was significantly affected by farmyard manure (P<0.05) and fertilizer application (P<0.05) and there was farmyard manure × fertilizer interaction (P<0.01). As the rate of farmyard manure application increased, the fruit weight per plant also increased. Fruit weight per plant was significantly influenced by varying the rates of fertilizer application up to 300 $kgha^{-1}$ beyond which it did not significantly increase. There was more response to Farm yard manure (FYM) at higher rates of NPK application. The mean fruit weight of cucumber per hectare ranged from 20,740.73 to 43,259.24 kg. The mean cucumber fruit weight per hectare was significantly affected by farmyard manure (P<0.05) and fertilizer application (P<0.05) and there was significant farmyard manure × fertilizer interaction (P<0.01). The fruit weight per hectare increased as the rate of farmyard manure application increased. Raising the rate of fertilizer increased the values significantly of the fruit yield per hectare up to the 300 $kgha^{-1}$ fertilizer rate. The 300 $kgha^{-1}$ and 400 $kgha^{-1}$ fertilizer rates had similar values. FYM was more effective in the production of high fruit weight in higher rates of NPK application.

DISCUSSION

In crop plants, dry matter accumulation is a result of nutrient uptake and one of the measures of plant growth (Noggle and Fritz, 1983). From the result of the study, it was evident that combining fertilizer and farm yard manure at any rate increased cucumber dry matter accumulation. This dry matter accumulation affected the number of fruits per plant, fruit length and fruit girth and the yield per hectare. The application of farmyard manure in combination with fertilizer resulted in increase in dry matter weights as each successive increase in FYM and fertilizer rates resulted in an appreciable increase in dry matter. But the application of farmyard manure at 10t/ha in combination with 400 kg of fertilizer led to an increase in the total dry matter content of the crop resulting in increased yield experienced in the treatments over the others. This was in agreement with the findings of Badaruddin et al. (1999) who posited that the application of farmyard manure resulted in significant increase in final above ground biomass in wheat. There was an increase in the number of fruits per plant, fruit weight per plant, fruit length and fruit girth and yield per hectare (Table 5). This was in line with Jarvan and Edesi (2009) who opined that the use of FYM on cultivated crops have higher dry matter content than those grown conventionally and hence increased yield. The nutrients absorbed by the cucumber plants were probably utilised in fruit, leaves and stem tissues formation which resulted in high yield and this was in agreement with Ibeawuchi et al. (2007) who posited that dry matter accumulation affected the grain yield and 1000 maize grain and dry matter accumulation is a measure of relative yield.

The analyses of the relationship between yield and yield components indicated a strong positive relationship between growth factors (leaf area and number of leaves), dry matter accumulation, yield and yield components except fruit weight per plant that had a negative correlation (Table 6).This indicates that leaf area, number of leaves, dry matter accumulation is important factors in yield formation in crops. This was in agreement with the findings of Board and Modali (2005) who postulated that there is a strong relationship between yield and yield components in soybeans. The positive correlation between total yields and the other growth factors, dry matter weights, yield and yield components except fruit weight per plant indicates that total yield and other yield components were dependent on growth factors and dry matter accumulation. The total yield is a function of the fruit per plant, number of fruits per plant and fruit girth. Lawal (2000), Roeggen (1977) Drews (1980) reported very high positive correlation between fruit length and cucumber fruit yield. The negative association between fruit weight and the parameters measured could be due to inhibitory effect of fruit development on the growth of subsequent fruits. Tiedjens (1928) reported that the developing cucumber fruit from first fertilized flowers had inhibitory effect on the growth of subsequently pollinated fruits.

Table 5. Correlation matrix of leaf area, number of leaves, dry matter weights, yield and yield components.

Yield component	1	2	3	4	5	6	7	8	9	10	11
Leaf area	1.00										
No. of leaves	0.513*	1.00									
Leaf dry matter	0.620	0.469*	1.00								
Stem dry matter	0.692*	0.586*	0.771*	1.00							
Fruit dry matter	0.691*	0.539*	0.758*	0.755*	1.00						
Total dry matter	0.795**	0.509*	0.939*	0.887*	0.889*	1.00					
Fruit wt./ plant	-0.399*	-0.548^{NS}	-0.306*	-0.489**	-0.398*	-0.439*	1.00				
Fruit no./ plant	0.724*	0.576*	0.788**	0.903*	0.724*	0.861*	-0.413	1.00			
Fruit girth	0.530*	0.587*	0.744*	0.688*	0.646*	0.775*	-0.337^{NS}	0.755*	1.00		
Fruit length	0.644*	0.728*	0.674*	0.664*	0.633*	0..718*	-0.424^{NS}	0.673^{NS}	0.690S*	1.00	
Yield/ha	0.834	0.647	0.788	0.832	0.876	0.879	-0.422	0.860	0.711	0.738	1.00

**,* Significant at 1 and 5%, respectively. N.S. Not significant. 1-Leaf area, 2 – No. of leaves, 3 - Leaf dry matter, 4 - Stem dry matter, 5 - Fruit dry matter, 6 - Total dry matter, 7 - Fruit weight per plant, 8 - Fruit no. per plant, 9 - Fruit girth, 10 - Fruit length, 11 - Yield / hectare.

Table 6. The effects of farmyard manure and inorganic fertilizer application on the yield and yield components of cucumber.

Yield component	FYM applied t/ha	NPK fertilizer rates kg/ha					
		0	100	200	300	400	Mean
	0	6.15	8.28	8.97	9.69	9.83	8.58
Number of fruits/plants	5	7.34	9.05	10.08	12.85	12.81	10.43
	10	8.41	9.71	11.79	11.94	12.42	10.85
	Mean	7.30	9.01	10.28	11.49	11.68	
LSD = P<0.05 FYM means 0.174, Fertilizer means NS, FYM ×Fertilizer means = NS							
Fruit girth (cm)	0	4.16	4.28	4.42	4.49	4.62	4.39
	5	4.74	4.97	5.02	5.06	5.48	5.06
	10	5.49	5.59	5.64	5.70	5.59	5.60
	Mean	4.80	5.95	5.03	5.08	5.23	
LSD = P<0.05, FYM means 0.172, Fertilizer means NS, FYM × Fertilizer means = NS							
Fruit length (cm)	0	14.20	14.27	14.54	15.18	15.39	14.72
	5	14.76	14.93	15.30	15.40	15.42	15.16
	10	15.40	15.55	15.53	15.55	15.71	15.55
	Mean	14.79	14.91	15.12	15.38	15.51	
LSD = P<0.05, FYM means = 0.284*, Fertilizer means = 0.334**, FYM × Fertilizer interaction means = 0.58 NS							
Fruit weight/plant	0	0.91	1.17	1.47	1.65	1.62	1.36
	5	1.21	1.47	1.61	2.22	2.23	1.75
	10	1.19	2.06	2.27	2.30	2.43	2.05
	Mean	1.10	1.57	1.78	2.06	2.09	
LSD = P<0.05, FYM means = 0.231**, Fertilizer means = 0.294**, FYM × Fertilizer means = NS							
Fruit yield/ha	0	16237.01	20740.73	26133.32	27392.24	28859.24	24272.57
	5	21511.10	26192.58	28681.46	39466.65	39644.43	31099.24
	10	21155.54	36681.46	40414.79	40888.87	43259.24	36479.24
	Mean	19634.55	27871.59	31743.19	36582.70	37254.30	
LSD = P<0.05, FYM means = 633.253*, Fertilizer means = 817.522*, FYM × Fertilizer means = 1415.981**							

*, ** Significant at 5 and 1%, respectively. N.S. Not significant.

Conclusion

The result of this experiment revealed that there is a relationship between FYM and fertilizer application on dry matter production in cucumber. Applying FYM and fertilizer at various rates resulted in an increase in dry matter production over the control. The dry matter production as well as the yield attributes of cucumber were significantly enhanced by the application of 10t/ha of FYM combined with 400 kg/ha of fertilizer and this same treatment also had more harvest window (12) than the other treatments (10).

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